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# Microbial water quality in clean water tanks following inspection and cleaning

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## Introduction

Clean water tanks should be cleaned and inspected regularly to remove e.g. sediments and to ensure that the structural integrity of the tanks is not compromised.

It is the desire of drinking water utilities to be able to distribute the drinking water to consumers immediately after the tanks have been cleaned, without preceding discard of large volumes of drinking water and without the use of disinfectant.

The Danish drinking water is ground water based, and there is no physical or biological barrier, such as UV-filter or supplying of chlorine, at the outlet of the clean water tanks.

## Project aim

The aim of the project was to investigate why increased bacterial counts are often measured after inspection and cleaning of clean water tanks.

Since increased bacterial counts may be an indicator of contamination or bacterial regrowth in drinking water systems the aim was to investigate whether the increased bacterial counts are due to intruding bacteria from the external environment or due to naturally present drinking water bacteria, not constituting a health risk.



## Results

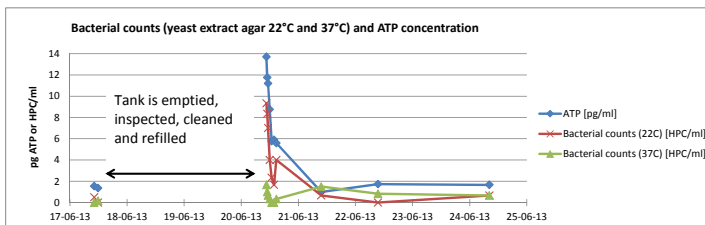
Sampling campaigns were carried out in two clean water tanks to investigate microbial water quality before, during and after cleaning of the tanks. Bacterial concentrations were quantified and dominating bacterial groups were identified.

Bacterial counts [yeast extract agar, 22°C] increased slightly after cleaning of the tanks, but did not exceed guideline values at any point during the investigations. Immediately after start-up, a maximum of 10 CFU/ml (Colony Forming Units) were measured in both tanks, and after less than

24 hours the concentrations were below 1 CFU/ml in both tanks. The low concentrations were maintained the following days. Bacterial counts [yeast extract agar, 37°C] were below 2 CFU/ml at all times.

To include bacteria not normally quantified by traditional methods, such as plating, we included ATP (Adenosin-Tri-Phosphate) measurements of the water. ATP is present in all living bacteria. ATP concentrations in the water immediately after start-up were high compared to the concentration of culturable bacteria which may indicate that bacteria from the sand filter e.g. nitrifying bacteria, which normally grow on substrates not present in the agar, were present in the water.

Ribosomal 16S rRNA sequences showed that the dominating bacterial groups were the same before and after the tanks were emptied, inspected and flushed. Furthermore the molecular results showed that functional filter bacteria such as the nitrite oxidizing bacteria *Nitrospira* sp. were transported from filter to clean water tanks and further into the distribution network.



## Perspectives

The use of DDS (Documented Drinking water Safety) has increased the focus on risk management when working with drinking water.

VCS Denmark has developed a DDS plan in which the risk assessment is based on HACCP (Hazard Analysis and Critical Control Point) and follows the principles of ISO 22000.

When inspecting and cleaning a drinking water tank, there is now focus on all aspects of the process through risk assessment.



Risk analysis		Probability			
		None	Low	Medium	High
Consequence	High				
	Medium			X	
	Low				

## Conclusions

- Bacterial counts [yeast extract agar, 22 and 37°C] increased slightly in the investigated tanks but did not exceed guideline values at any point during the investigations
- No pathogens or indicator bacteria were detected in water, sediment or biofilm
- ATP concentrations increased more than concentrations of culturable bacteria in water leaving the tanks after cleaning. This indicates that bacteria from the sand filter, which do not grow on agar plates, were present in the water
- Ribosomal 16S rRNA sequences showed that the dominating bacterial groups were the same before and after the tanks were emptied, inspected and flushed. Functional filter bacteria, such as the nitrite oxidizing bacteria *Nitrospira* sp., were transported from filter to clean water tanks and further into the distribution network

